ISSN:2348-2079

Volume-8 Issue-3

International Journal of Intellectual Advancements and Research in Engineering Computations

Effect of natural fiber composites against surface treatment

M.Bhuvaneshwaran[1], S.Barani kumar[2], E.Karthick[2], S.Karthik[2], S.Balaji[2]

[1]Assistant Professor, Department of Mechanical Engineering, K.S.R. College of Engineering, Tiruchengode, India

[2]Scholars, Department of Mechanical Engineering, K.S.R. College of Engineering, Tiruchengode, India

ABSTRACT

Low density, low cost, environmental compatibility, wide availability, and high mechanical performance of raw materials are some considerable advantages of natural fiber composites. Sisal, very common type of natural fiber, is abundantly available in Ethiopia. This research aims to investigate mechanical properties of sisal reinforced composites such as tensile, flexural and impact strength. Fabrication of samples used the hand lay-up process with 15, 25, 30, 35, and 40 wt% sisal fibers to epoxy ratio. Tests for the properties indicated were made using the instron material testing system. Test results demonstrated, among the samples, that 30 wt% of sisal fiber-reinforced composites have the maximum tensile and flexural strength of 85.5 MPa and 85.79 MPa respectively. The impact strength has been found to be maximum for 40 wt% sisal fiber which is 24.5 kJ/m^2. As the result show, and compared with other researcher findings, the mechanical properties are acceptable as substitutes for applications demanding low-cost engineering applications such as automotive internal parts including interior door panel, back seat and body panels.

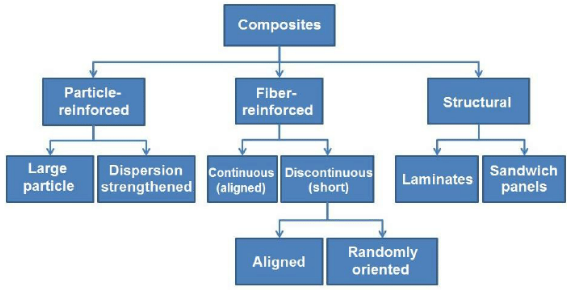
Keywords: Sisal fiber-reinforced, Epoxy, Hand lay-up method.

INTRODUCTION

In recent years, thermoplastic materials are being increasingly used for various applications [1]. Because of their increasing use combined with the high demand, the cost of the thermoplastics has increased rapidly over the past decade. This situation made it necessary to use low cost fillers as a means of reducing the cost of the end product. However, the widely used inorganic fillers, such as glass fibre and mica are very expensive compared to natural fibres [2]. Natural fibre-reinforced thermoplastic composites are more economical to produce than the original thermoplastics and, as a result, it may be possible to meet any future shortage of thermoplastics [3]. Moreover, the use of natural fibre in thermoplastic composites is highly beneficial, because the strength and toughness of the plastics can be improved. However, lack of good interfacial adhesion and poor resistance to moisture absorption made the use of natural fibre reinforced composites less attractive [4]. This problem can be overcome by treating these fibres with suitable chemicals. Among the various natural fiber composites, sisal fiber-reinforced composites produce superior impact strength with moderate tensile and flexural properties, making them potential alternatives for applications that require good impact strength.

Author for correspondence:
Department of Mechanical Engineering, K.S.R. College of Engineering, Tiruchengode, India

METHODOLOGY



MATERIALS AND METHODS

Materials

To make sisal-epoxy sample plates, the hand lay-up techniques are used. Sisal fibers are extracted from the sisal plant leaves by hand using a knife. The fibers were washed and separated until individual fibers are clearly identifiable, then sun-dried and cut to a length of 300 mm. Alkali treatment using 10% NaOH was employed to enhance the adhesion property of sisal epoxy fiber, improving the mechanical behavior of the composite. In this treatment, the fibers are soaked in NaOH solution for 3 h and then washed using distilled water to remove the traces of NaOH. The fibers were dried-up by being left outdoors for 48 h. A steel mold having a dimension of 290 × 200 × 7 mm is used to prepare sample plates. Polymer matrix was prepared from epoxy system #2000 combined with system #2060 hardener which enables its mechanical properties to be shown on the material safety data sheet. The epoxy in liquid form is mixed thoroughly with the prescribed hardener and poured into all the layers of sisal fibers while being placed onto the mold and made to spread uniformly manually.

Epoxy resin & Hardener

We choose the epoxy and the hardener manufactured by HUNTSMAN International (India) pvt ltd Mumbai, India. The trade names of the epoxy and the resin are LY556 and HY951 respectively. The epoxy and the hardener are employed in the ratio of 10:1.

CHEMICAL TREATMENT OF SILANE FIBER

The alkali treated dried fibres were placed in a round bottomed flask and soaked with an appropriate volume of CC14 and a little (1 ml) dibutyl tin dilaurate catalyst. The round bottomed flask was fitted with a pressure equalizing funnel containing the urethane derivative. The urethane derivative was added into the flask drop wise with sufficient stirring [5]. After the complete addition of urethane, the reaction was allowed to continue for one more hour. The urethane treated fibres were purified by refluxing with acetone for 8 h in a Soxhlet apparatus followed by repeated washing with distilled water. Finally, the fibres were oven dried at 80°C.

Dicumyl peroxide treatment

The alkali treated fibres (30g) were soaked with 11 of a 6% solution of DCP in acetone for 30 min. The solution was decanted and the fibres were air dried. NaOH pre-treated fibers are kept dipped for 15 minutes in 10% NaOH and in Benzoyl chloride solution of different concentration like 4%, 5%, 6% & 7%.

Benzoyl peroxide treatment

A similar procedure adopted as in the case of DCP was used here.

Potassium permanganate treatment

The alkali treated fibres (30 g) were soaked with 11 of KMnO4 solution in acetone having different concentrations (0.005-0.205%) for 1 min. This was then decanted and the fibres were dried in air.

Silane treatment

Silane acts as a coupling agent between the natural fiber and the polymer matrix, enabling the stabilization of the composite material. Fibers pre-treated with NaOH were immersed in solution (160/40 by volume) of 3-aminopropyl trimethoxy Silane of various concentrations ranging from 1 wt% to 4 wt% with 1 wt% interval with added water and ethanol solution.

MECHANICAL TESTS FOR COMPOSITES

According to the ASTM standard, composite plates were cut into several test specimens. Computer controlled Kalpak universal testing machine was employed to conduct tests as per various ASTM standards like ASTM D3410, ASTM D790 & ASTM D3039. The tests such as compression strength, tensile strength and three-point flexural strength on the composite were conducted.

RESULT & DISCUSSIONS

Tensile tests

Tensile tests are used to determine modulus and strength. Tensile strength at peak and yield loads has been investigated to evaluate its modulus of elasticity and percent elongation at break for samples of varying fiber content. For tensile tests, dog bone-shaped specimens are put in an instron load frame model 8511 universal testing machine and stretched until broken. Specimens featuring both randomly oriented and directionally aligned fibers are tested as specified with speed of extension at 10 mm/min. Five test specimens are cut and tested from each sample plate in order to enable determination of average result values.

Flexural tests

Flexural tests are performed using an instron load frame model 8511 universal testing machine according to the [18] ASTM D 7264/7264 M-07 standard test methods. Flexural tests are used to determine flexural stress at peak load, strain at peak load, and chord modulus. Procedure A is followed where the specimen is held by two cylindrical support noses while a third cylindrical loading nose applies a force to the center of the specimen, causing it to bend.

Impact tests

Specimens are prepared for the Izod impact test according to [20] ASTM D256, ISO 180, using test method A with a pendulum capacity of 2.74 J. he impact properties of the composites are studied by applying an indentation load normal to the specimen's longitudinal axis. A notched specimen is secured with the notch facing the approaching pendulum. The pendulum breaks the specimen is the height of the pendulum swing is corrected for wind resistance. Specimen breaking energy is calculated automatically by the impact test machine.

CONCLUSIONS

- The natural fibers have been successfully reinforced with the epoxy resin by simple wet hand lay-up technique. The aim of this project is to find the Tensile, Bending, ILSS and impact strength of natural fiber reinforced bio-composites.
- The fibers like jute fibers, coconut coir, areca nut fibers, and sisal fibers were successfully used to fabricate bio-composites with varying the fiber percentage.
- The new hybrid composite produced with natural fibers as reinforcements gives good mechanical properties as compared with pure matrix material. These hybrid- bio-composite can be used in Aerospace and automobile applications.

In the present work, bio-composite with multiple natural fibers such as jute fibers, Coconut coir, areca fibers, sisal fibers, banana fibers have been successfully reinforced with the epoxy resin by simple and inexpensive hand lay-up technique. The mechanical testing results of fabricated bio composite helmet indicate that, concept of using multiple natural fibers is viable for helmet application. However, there is a scope to optimize the volume fraction of natural fibers as reinforcements to achieve enhanced mechanical properties of helmet. So, it is clearly indicates that reinforcement of natural fibers have good and comparable mechanical properties as conventional composite materials.

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